Technique Improves Printing Quality for 3D Nanoprinting (#8478)

Broadens industrial applicability for printing micro- and nanoscale structures

GT innovators have developed an optical projection technique that improves printing quality for a novel additive manufacturing strategy, enabling cost-effective, large-scale 3D nanoprinting.

Femtosecond projection two-photon lithography (FP-TPL) is a nanoscale 3D printing technique that fabricates tiny structures a thousand times faster than conventional TPL techniques, without sacrificing resolution.

However, the technique requires tuning process parameters—including photopolymer material properties—to minimize defects due to over-polymerization. Georgia Tech researchers have altered the optical projection technique to control over-polymerization defects without the need to tune the photopolymer composition. This modification further reduces the aspect ratio of the submicron features from more than 2 to 1.2, resulting in well-defined structures and transforming FP-TPL into a more robust process suitable for high-throughput, high-quality 3D printing of micro- and nanoscale structures.

Benefits/Advantages

- **High-performance**: Enables a powerful process for high-throughput 3D printing of micro- and nanoscale structures
- **Efficient**: Reduces defects during printing to improve yield and decrease excess printing commonly observed with FP-TPL
- **Improved**: Broadens the applicability of FP-TPL to printing of functional micro- and nanoscale structures

Potential Commercial Applications

- Photonic crystals
- Mechanical metamaterials
- Micromachines
- Miniaturized optics
- Flexible electronics
- Bio-scaffolds

Background/Context for This Invention

Current technologies for fabricating complex 3D micro- and nanoscale structures are limited to point-by-point writing techniques that are very slow. For example, printing a millimeter cube of material can take up to 100 hours. Therefore, many promising devices that use these structures cannot be printed at the high throughputs required to scale them up for industrial use. The FP-TPL printing technique improves upon previous technologies by increasing the rate by a thousand times without comprising the sub-micrometer feature size resolution. This Georgia Tech innovation further improves upon the FP-TPL printing process by reducing defects during printing, which will improve yields and reduce time and costs associated with wastage.

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More Information

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Publications

Defect control during femtosecond projection two-photon lithography, Procedia Manufacturing 48C (2020) pp. 650-655, (Not Yet Published)

Scalable submicrometer additive manufacturing, Science, October 4, 2019

3D Printing Technique Accelerates Nanoscale Fabrication a Thousandfold

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For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/technique-improves-printing-quality-3d-nanoprinting

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot